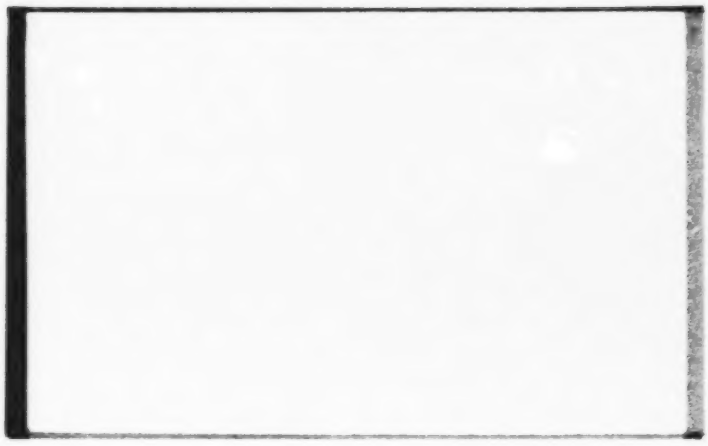
ENERGY USE ENGINEERING DEPARTMENT

PROJECT 8216

IMPACT OF RAIL ELECTRIFICATION ON B. C. HYDRO ELECTRICAL SERVICE NEEDS 1983 - 2005

ENERGY CONSERVATION DIVISION

B.C. HYDRO AND POWER AUTHORITY



ENERGY USE SERVICES

The Energy Use Engineering Department provides engineering, technical and marketing impact advice on energy use with emphasis on energy management, prudent energy usage, efficient applications and energy conservation.

The service is provided by a team of four sections supervised as follows:

*HEATING, AIR CONDITIONING, VENTILATION & REFRIGERATION	Dr. Z. El-Ramly, P.Eng.	(663-3277)
*ELECTRICAL & LIGHTING (including associated wiring, electronics, and codes)	R.F. Hughes, P.Eng.	(663-3280)
*RESIDENTIAL APPLICATIONS (including associated appliances, lighting, wiring, water heating, electric and gas vehicles, solar, small hydro, wind, wood, and biomass)	J.E. Elliott, P.Eng.	(663-3285)
*APPLICATIONS ENGINEERING (primarily commercial and industrial — including associated total-energy district and waste water applications; electric and gas vehicles, and power factor and demand control)	M.W. Bodnar, P.Eng.	(663-3288)

Please don't hesitate to contact us should you require additional information or should you have any suggestions on how we can better provide the service required.

R.W. RACINE, P.ENG.
MANAGER, ENERGY USE ENGINEERING DEPARTMENT
(604)663-3268 (TELEX 0454395)

ENERGY USE ENGINEERING DEPARTMENT
ENERGY CONSERVATION DIVISION
B.C. HYDRO AND POWER AUTHORITY

625 HOWE STREET
VANCOUVER, B.C.
V6C 2T6

PROJECT 8216

IMPACT OF RAIL ELECTRIFICATION ON B. C. HYDRO ELECTRICAL SERVICE NEEDS 1983 - 2005

SYNOPSIS:

Electric trains can become a major load to B. C. Hydro in the next two decades. By the year 2005 it is estimated that 3,523 GW.h/year will be consumed by the electric trains (450.7 MW demand at 0.6 LF).

PROJECT:

Initiated by:	R. W. Racine
Date Completed:	28 February 1983
Completed by:	G. B. Ilic
Supervised by:	M. W. Bodnar
Approved by:	R. W. Racine, Manager Energy Use Engineering
Initial Distribution:	T. J. Newton EUE Department Supervisors G.D.A. Henriques G. B. Ilic

Canadian Cataloguing in Publication Data

Main entry under title:
Impact of rail electrification on B.C. Hydro electrical service needs 1983-2005

Caption title.
Bibliography: p.
"Project 8216"
ISBN 0-7719-9215-7

1. Electric railroads - British Columbia - Energy consumption. 2. Electric power consumption - British Columbia - Forecasting. I. B.C. Hydro. Energy Use Engineering Dept.

TF863.I46 621.33 C83-092155-9

ENERGY USE ENGINEERING DEPARTMENT

PROJECT SUMMARY

PROJECT NO. 8216 PRIORITY 2

TITLE: Impact of Rail Electrification on B. C. Hydro's Electrical Service Needs, 1983 - 2005.

INITIATED/REQUESTED BY: R. W. Racine

ASSIGNED TO: G. B. Ilic ASSIGNED BY: M. W. Bodnar

DATE ASSIGNED: 2 June 1982 DATE REQUIRED: ASAP

ESTIMATED COMPLETION: 1982 COMPLETED:

OBJECTIVES AND NOTES:

The objective of this project is to harness the expertise available in the EUE Department and elsewhere as appropriate to develop the potential impact of rail electrification on the B. C. Hydro electric system in the 1983 - 2005 period. This should include the transcontinental rail links, rapid transit and other rail systems which may be converted to electricity.

This report will take the form of a preliminary data sheet complete with tables and will form a part of Impact Report 8130, "New Applications".

COPIES TO: DEPARTMENT MANAGER (THEN RECORD FILE), BLUE FILE, SUPERVISOR, (M.W. Bodnar), EUE Supervisors, G.D.A. Henriques, G.B. Ilic, R. Schneider

PLEASE ADVISE AS SOON AS POSSIBLE IF CHANGES ARE REQUIRED ABOVE

ENERGY USE ENGINEERING DEPARTMENT
ENERGY CONSERVATION DIVISION

B.C. HYDRO

D78-459(80/6)

TABLE OF CONTENTS

		Page
1.0	EXECUTIVE SUMMARY	1
2.0	RECOMMENDATIONS	2
3.0	INTRODUCTION	2
4.0	PARTICIPANTS IN RAIL ELECTRIFICATION B. C.	4
5.0	PARTICIPANTS IN RAIL ELECTRIFICATION CANADA	4
6.0	CONTACTS - B. C. HYDRO - SOURCES OF INFORMATION	5
7.0	B. C. SUMMARY OF RAIL ELECTRIFICATION	6
8.0	REFERENCES AND SOME FURTHER READING	7

APPENDICES

APPENDIX A	1. WHY ELECTRIFICATION BENEFITS UTILITIES 2. A DIESEL ADVANTAGE VS ELECTRIC ADVANTAGES 3. THE COSTS OF ELECTRIFICATION
APPENDIX B	RAILWAY ELECTRIFICATION - DEMONSTRATION OF THE BCR TUMBLER RIDGE BRANCH LINE ELECTRIC OPERATION
APPENDIX C	NORTH EAST COAL DEVELOPMENT
APPENDIX D	CPR CALCULATIONS - CALGARY VANCOUVER LINE
APPENDIX E	ALRT - GREATER VANCOUVER
APPENDIX F	BRITISH COLUMBIA RAIL ELECTRIFICATION
APPENDIX G	RAIL ELECTRIFICATION OF B.C. PORTION OF THE CPR LINE, CALGARY - VANCOUVER

ACKNOWLEDGEMENT

Special thanks are due to Mr. Bill McGarry of EM&R, Ottawa, member of the Standards Subcommittee of the Railway Electrification Committee who supplied much of the data tabled in this report (Sections 1 and 7).

Mr. A. Loewen, B. C. Hydro's Special Contracts Engineer, kindly supplied many background references, in addition to the verbal communications from B. C. Hydro contact people listed in Section 6.

1.0 EXECUTIVE SUMMARY

Electric trains have a potential of becoming a major load on B. C. Hydro's system.

The following table offers an overview of this potential in British Columbia.

Line	Company	Miles	Consumption, MW.h/Year 1985	1990	1995	2000	2005
Tumbler Ridge to Anzac	BCR	80.0	35,261	35,261	35,261	35,261	35,261
Field to Golden	CPR	35.0	59,815	103,540	132,480	132,480	132,480
Golden to Vancouver	CPR	428.7	1,162,662	1,162,662	1,162,662	1,162,662	1,162,662
Crowsnest to Golden	CPR	238.0	291,383	520,423	813,351	813,351	813,351
Lucerne to Red Pass	CNR	22.1	24,455	34,395	48,376	68,039	68,039
Red Pass to Port Mann	CNR	467.1	281,428	502,630	897,769	1,311,565	1,311,565
Chilliwack to Vancouver	BCHR	194.4				possibilities	
Greater Vancouver	ALRT	60.0		2,610	5,220	6,900	8,700
Total GW.h			1,855	2,361	3,095	3,530	3,531
Electrified lines within B. C.		1545 mi (2456 km)					

Figure 1: Electric Rail Potential in B. C. - 1985-2005(Modified from Ref.1)

To compare the above consumptions with 1981/1982 figures, B. C. Hydro total electrical sales in B. C. amounted to 28,295 GW.h (total of generated 39,250 GW.h included 6,984 GW.h of exports and 3,971 GW.h of line losses and system use). The system peak was 5902 MW.

The plans to electrify the above lines are contingent on the economics of electrification. It is estimated that over $1 billion of capital investment will be needed to realize these plans (see Section 8).

The principal "pilot project" for rail electrification will be B. C. Railway's 129 km (80 mi) branch line built in the northeast of B. C. (Anzac to Tumbler Ridge) to bring the metallurgical coal from the Quintette and Teck Corp. coal mines to Prince Rupert (Ridley Island) and make it available for export. The first trains on this line will run in 1984. The success of this project will undoubtedly affect the electrification of the other lines shown in Figure 1.

The major factors whether this potential train electrification will be realized or not remain the relative economics of operation between the electric trains and the fossil fuel ones. Political decisions, technological developments and major marketing efforts will also have a role in making rail electrification happen.

B. C. Hydro's load forecast makes no allowance for rail electrification for now. This may well change in future based on BCR's example.

The technologically advanced MAGLEV trains will probably not appear in B. C. in the next 20 years because of B. C.'s rugged terrain and the emphasis on freight.

2.0 INTRODUCTION

The studies of rail electrification were conducted in the 19th century as well as today. Numerous references listed in Section 8 mention the various studies and achievements in this field.

This report gives a brief overview and resume of the current studies and projections for the development of railroad electrification in B. C. in the next 20 years.

The appendices of the report give more details of rail electrification - starting with a state-of-the-art review in Appendix A, giving details of the first major project now under way in Appendices B and C, and listing CPR calculations for their line electrification in Appendix D. The automated light rapid transit (ALRT) in the Lower Mainland is now under construction and that load has been included in B. C. Hydro's plans. A map showing the location and a brief overall summary of that project is included as Appendix E.

3.0 RECOMMENDATIONS

In view of the interst and uncertainties in Rail Electrification in B. C., the following recommendations are made to keep up to date with the developments in this field.

3.1 Monitor progress in rail electrification related issues on an ongoing basis.

N.B. EUE's Applications Engineering Section is opening a file which will contain such an update of engineering and economic aspects of rail electrification in the world, with specific interest in B. C.

3.2 Issue progress reports periodically; one to two-year intervals will be sufficient for forecasting purposes.

3.3 Investigate Figure 1. If such potential load is found to be desirable to B. C. Hydro it will be necessary to develop a strategy how to go about obtaining this load.

Special marketing, negotiations with railroad companies, fuel economics, lobbying allies (e.g. Chapter 5) public relation campaign as well as new technological advances will undoubtedly have to be considered in the strategic planning of such a program.

4.0 PARTICIPANTS IN RAIL ELECTRIFICATION - B. C.

4.1 British Columbia Railway

The front runner in the field in B. C. and Canada, BCR is the first company to actually commit itself and build an electric train line in B. C. from Anzec to Tumbler Ridge using advanced 50 kV technology.

The key factors that made BCR decide on the electric trains for the branch line were:

- $15 million saving in avoiding tunnel ventilation costs;
- proximity of B. C. Hydro 230 kV transmission line;
- availability of federal and provincial energy conservation funds to help finance the project.

Appendices B and C describe the above project in more detail because of its significance as a pilot project and its influence on future rail electrification decisions.

4.2 Canadian Pacific Railway

CPR and BCH formed a joint task force in 1972 (Ref 16) which evaluated the feasibility of electrification of Calgary-Vancouver line. The general CPR attitude toward electrification as well as that of all the other potential "players" in the rail electrifications game was "wait and see" until it became an economically viable alternative to the hydrocarbons.

However there was an upsurge of activity in this field in 1981 and CPR has come out with new calculations and projections which are summarized in Figure 1, and shown in some detail in Appendix D.

4.3 Canadian National Railway

The attitude of CNR toward the rail electrification in mid 70's is quoted from CNR's Submission to the Royal Commission on Electric Power Planning, August 1977:

> "There is virtually no commercial incentive for the Corporation to make the appropriate investments since costs are too large and immediate and the benefits too uncertain and distant for the railways to assume this financial risk."

Since the formation of the Railway Electrification Committee (1981) (see Section 6), there are a number of projects dealing with the feasibility of various projects. CNR's two projects are summarized in Figure 1.

4.4 B. C. Hydro and Power Authority Railway

B. C. Hydro is also interested in electrifying its own line from Chilliwack to Vancouver/Richmond.

There is no engineering study to electrify this line now but indications are that such effort will take place by mid 80's.

Current diesel locomotives are due for replacement by 1989 so that this time would be a good time to consider changeover to the electrics.

4.5 ALRT

"The Automated Light Rapid Transit", fast commuter train in the Lower Mainland area is under construction now. The completion of the first priority line is scheduled for 1986. Appendix E shows the location of this project. Load calculations for the ALRT are still unavailable, 1.5 MVA seems to be the figure used for early phases, going to 4.5 - 5 MVA, for when the whole system is in operation.

N.B. For the purposes of Figure 1, I have assumed a load factor of 20% for ALRT.

5.0 PARTICIPANTS IN RAIL ELECTRIFICATION - CANADA

5.1 Railway Advisory Committee (RAC) founded in 1973. CEA Representative in RAC is Gaston Boucher, Hydro Quebec, tel (514) 289-3358.

5.2 Railway Association of Canada.

5.3 Transportation Development Agency (TDA), now TDC.

5.4 Railway Electrification Committee (1981) has representation from all appropriate government departments, the railways, provinces and utilities.

5.5 CIGGT, Canadian Institute of Guided Ground Transport, Queen's University, Kingston, Ontario. Contact Mr. G. W. English, tel (613) 547-5777.

5.6 Energy Mines and Resources Canada, Ottawa. Contact Mr. W. (Bill) McGarry, tel (613) 995-1118.

5.7 EEMAC Electrical and Electronic Manufacturers Association of Canada.

6.0 CONTACTS - B. C. HYDRO

(Bob) Brassington, Manager, Special Power Contracts (CPR, CNR, BCR contact)	tel 663-2692
(Marc) Bradwell, Area Transmission Planning Spvr (between station and load)	tel 663-2342
(Jack) Hardy, System Transmission Planning Spvr (between BCH stations)	tel 663-2715
(Jerry) Stevenson, Manager, Railway Operations Div (B. C. Hydro's Railways)	tel 521-1966
(Ed) Roberts, Area Distribution Engineer (ALRT load)	tel 298-2411
(Grad) Ilic, Energy Utilization Engineer Energy Use Engineering Department (general background and specific information and updates on rail electrification as covered in this report)	tel 663-4205

7.0 COST OF RAIL ELECTRIFICATION IN B. C.

Figure 2 is a summary of studies constructed by the Canadian Institute of Guided Ground Transport of Queen's University, Kingston, Ontario as communicated in Reference 1, dealing with the costs of different phases of rail electrification in B. C.

These costs do not include the Anzac-Tumbler Ridge Line, ALRTA line nor BCHR possible project.

Phase	Cost, Million $
Substations	129,840
Civil Reconstruction	140.425
Catenaries	567.617
Utility Feedline	89.280
Communications	21.875
Total	949,037

Figure 2: Cost of Rail Electrification in B. C. 1985-2005

Another set of figures in the same study estimates these costs to be $1.04 billion. Further breakdown of the various phases of rail electrification is summarized in Appendix F.

8.0 REFERENCES AND SOME FURTHER READING

8.1 W. F. McGarry, EM&R Canada, Private Communication, Feb 1983.

8.2 W. F. McGarry, Presentation at the "Railway Electrification" meeting EEMAC in Toronto, 11 Nov 1982.

8.3 "Electric Trains No Toy at B. C. Coal Site", EC & MS, Nov 1982.

8.4 "Railways Are a Top National Priority", Electrical World, Oct 1982.

8.5 "Electromagnetic Compatibility", L. D. Tufts, Canadian Pacific Limited, Railway Electrification Seminar, Canadian Institute of Guided Ground Transport, Kingston, Ontario, 9-10 Mar, 1981.

8.6 "In 'Flying' Trains, the U. S. is the Caboose" Bus. Week 25 Feb, 1980.

8.7 "France's Superfast Train" EIII Spectrum, July 1982.

The following references are in B. C. Hydro's main library:

sheet 1-11; computer search sheets on file in the Applications Section file show additional references.

8.8 ASCE/EIC/RTAC HB 011
Joint Transportation Engineering Meeting
Montreal, 15-19 July, 1974.
"Railroad Electrification", R. Klein

8.9 "Could electrification to U. S. follow HB 004
the European pattern?"
Railway Locomotives and Cars, June/July 1974

8.10 "Electrification: Is it going to happen?" HB 007
by William D. Middleton.
Railway Age.

8.11 "Electrification talk is getting serious."
Railway Age, 24 November, 1980, page 26.

8.12 "Electrification: who will be first?"
Railway Age, 8 June, 1981, page 34.

8.13 "Electrification: FRA's $20-billion program."
Railway Age, 13 October, 1980, page 12.

8.14 "Railview" Coal vs. electrification."
Railway Age, 27 July, 1981, page 90.

8.15 "The Next Golden Age of Trains."
by John Francis. Quest, June 1981, page 10.

8.16 Power Supply to the B. C. Section of the CP PAM 621.33 C3
Rail Calgary - Vancouver Main Line
Electrification Phase I Report of CP Rail
B. C. Hydro Task Force, September 1972.

8.17 Railroad Electrification
Edison Electric Institute. 3 Vols.

8.18 Railroad Electrification, by Thomas Vanderslice
Public Utilities Fornightly, Vol 94, No 7,
p.63-65A, 26 September, 1974.

Why electrification benefits utilities

Electric utilities stand to benefit from both passenger and freight electrification in a number of ways. Primarily, utilities will be helped at the front and back ends of generating stations: Coal fuel, carried by unit trains from mine mouth to powerplant, will arrive swiftly and efficiently, hauled by electric locomotives fed from 25- or 50-kV, 60-Hz (commercial freuqency) electricity supplied to the catenaries by nearby powerplants—without the previously required frequency-converter stations for stepping down to 25 Hz.

Faster schedules are also possible with all-electric traction because of higher acceleration rates and shorter turnaround time (diesels require refueling). Furthermore, electric-motive power is cleaner and quieter.

The utilities will also supply the electric energy, at commercial frequency, to operate the all-electric locomotives and multiple-units for main line, suburban-commuter, and urban mass-transit-system passenger service. Thus, the transmission of electric power to the railway lines should be measurably facilitated by the use of commercial frequency.

Finally, utility revenues should be greatly enhanced by this large new source of electric-power application. (Harry Rappaport of Amtrak tells EW that the electricity consumption for the entire electrified system of the old Pennsylvania Railroad—New York City to Washington, Philadelphia to Harrisburg, and Columbia to Perryville, Md—has averaged about 53-million kWh/month over the past year, with a peak demand of about 110,000 kW.) Al Engel of Gibbs & Hill, estimates that the projected Harrisburg-Pittsburgh 250-route-mile electrification—a heavy-density freight route—would require about 720-million kWh annually.

Another cost figure received by EW indicates that it requires 800 kWh of electricity per 1,000-gross-ton miles, or about 0.8 kWh/ton-mile.

A diesel advantage vs electric advantages

The primary advantage of the diesel-electric locomotive is its versatility: It can be used over any division of any main line or branch line of any standard railroad system in the US, Canada, and Mexico. On the other hand, the diesel-electric must carry its own powerplant and fuel and, therefore, reaches limitations on size and weight at a power output of about 3,000 kW on six axles. But an electric locomotive of corresponding weight can be built at a rating of 5,200-6,000 kW. In short then, one electric can do the work of two diesel-electrics. Also, the initial cost of an electric locomotive is approximately 20% less than that of a diesel-electric with the same power rating.

In the area of maintenance costs, the electric again has the edge: A 16-cylinder diesel engine has more than 9,000 parts, of which about 2,700 are moving; the equivalent transformer of the electric locomotive has no moving parts. Thus, there are electric locomotives—such as the "GGIs" of the old Pennsylvania RR—placed in service more than 45 years ago, still providing excellent performance.

The costs of electrification

Depending on the degree of sophistication, the topography of the terrain, the type of service (high-speed passenger; mixed freight/passenger; low-speed, heavy-haul freight; suburban commuter; etc.), the relative costs of railway electrification can vary as widely as those between a VW Rabbit and a Rolls-Royce Silver Cloud.

Harry Rappaport, an electric-traction design engineer for Amtrak, estimates that electrification cost per route-mile for a two-track, high-speed line (such as the one proposed between Harrisburg and Pittsburgh) could run as high as $1.25-million. Included in this cost are the 25-kV, 60-Hz catenaries and their supporting structures; right-of-way upgrading and installation of new roadbed and track as required; modification and improvement of the signal, communications, and automatic-train-control (ATC) systems; substations; land purchase; and payments to utilities for bringing power from their transmission lines into the substations. Not included in this estimate is the cost of traction equipment—electric locomotives or multiple units, and rolling stock.

Rappaport says, however, "We have received cost estimates for electrification that range from a low of $100,000 to as much as the $1.25-million figure just quoted per route-mile."

Ed Schwarm, senior staff consultant for Arthur D. Little Inc, says the entire package cost for an eastern railway's two-track, 25-kV, 60-Hz electrification project (similar to the proposed Harrisburg-Pittsburgh line)—including catenaries and their support structures, substations (spaced 18 miles apart), signal modification, and transmission-line taps, would be about $508,000 per route-mile.

For a western railway, however, assuming a one-track line, with 30% sidings, a catenary energized at 50 kV, 60 Hz, substations spaced 40 miles apart—and with the necessary signal and communication modifications—Schwarm estimates the cost at about $300,000 per route-mile.

Locomotive-maintenance costs

Dave Wuestmann, of Gibbs & Hill, says that on the proposed Harrisburg-Pittsburgh line, locomotive-maintenance costs "are estimated to be about $1.46 per thousand gross-ton miles for diesel-electric locomotives, compared with only $0.36 for all-electric locomotives. Based on a locomotive unit mile, the maintenance cost for diesel electrics is estimated at $2.46 vs $1.33 for an electric locomotive of similar tractive power."

The above texts were extracted from "Electrification Returns to the Railroads", by G. D. Friedlander, Electrical World, December 1982.

RAILWAY ELECTRIFICATION

DEMONSTRATION ON THE BRITISH COLUMBIA RAILWAY

TUMBLER RIDGE BRANCH LINE ELECTRIC OPERATION

1. UNIT COAL TRAINS BETWEEN NORTHEAST B.C. MINES AND PRINCE RUPERT

2. UNIT TRAIN CONSIST - 4 ELECTRIC LOCOMOTIVES
   - 98 COAL CARS (12,920 TONS)
   - 1 CABOOSE

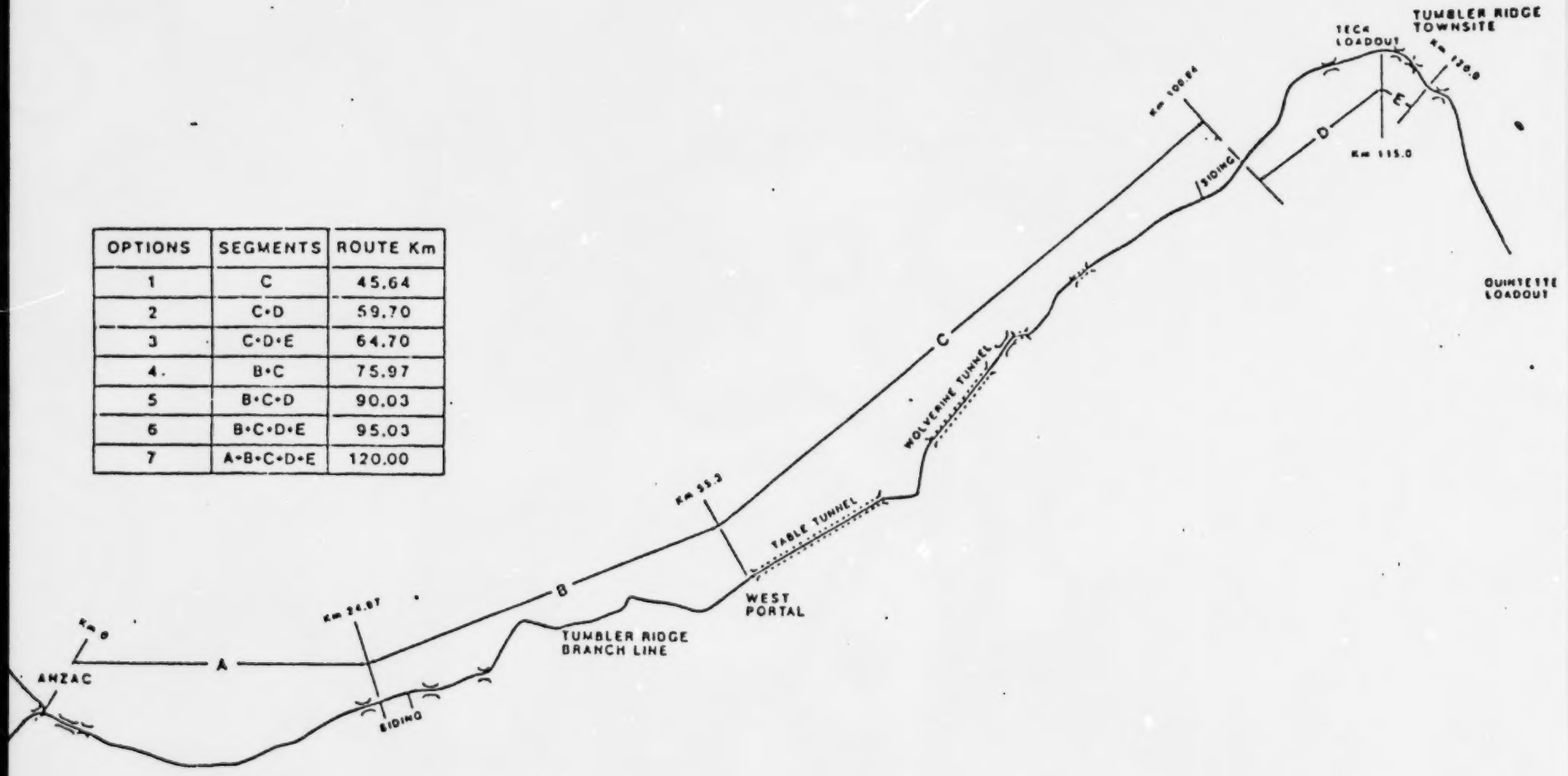
3. TRAIN CREWS - MINE SITE TO PRINCE GEORGE: BCR
   - PRINCE GEORGE TO PRINCE RUPERT:CN RAIL

4. TUNNEL VENTILATION - NONE REQUIRED

NOTE: NON ELECTRIFIED OPERATION WOULD REQUIRE EXTENSIVE TUNNEL VENTILATION BECAUSE THREE DIESEL-ELECTRIC LEAD LOCOMOTIVES PLUS THREE DIESEL-ELECTRIC PUSHER LOCOMOTIVES WOULD BE REQUIRED

Figure 3.1
ELECTRIFICATION OPTIONS
TUMBLER RIDGE BRANCH LINE

OPTIONS	SEGMENTS	ROUTE Km
1	C	45.64
2	C•D	59.70
3	C•D•E	64.70
4.	B•C	75.97
5	B•C•D	90.03
6	B•C•D•E	95.03
7	A•B•C•D•E	120.00



RAILWAY ELECTRIFICATION

DEMONSTRATION ON THE BRITISH COLUMBIA RAILWAY

OPERATIONS COST DIFFERENTIAL

1.	DIESEL-ELECTRIC OPERATION	
	1.1 TUNNEL VENTILATION	$19.5M
	1.2 DIESEL-ELECTRICS	$23.3M
	TOTAL	$42.8M
2.	ELECTRIC OPERATION	
	1.1 POWER SUPPLY AND CATENARY	$28.4M
	1.2 ELECTRICS	$28.6M
	TOTAL	$57.0M
3.	DIFFERENTIAL COST	$14.2M
4.	BCR REQUEST TO CREDA	$14.2M
	- BC ENERGY	$ 7.1M
	- EMR	$ 7.1M

BCR DEMO

ENERGY CONSUMPTION AND COSTS COMPARISON

	OPERATION	
	ELECTRIC	DIESEL
FUEL USED PER YEAR	35,261,000 KWH	1,958,000 GAL.
FUEL IN EQUIVALENT UNITS	127,000 GJ	343,000 GJ
ANNUAL COST OF FUEL ($1982)	$1,715,000	$2,445,000
ELECTRIC OPERATION	REDUCTION OF 63% (GJ)	
DIESEL LOCOMOTIVES	27% THERMO-MECHANICAL EFF.	
ELECTRIC LOCOMOTIVES	76% ELECTRO-MECHANICAL EFF.	

RAILWAY ELECTRIFICATION

DEMONSTRATION ON THE BRITISH COLUMBIA RAILWAY

EXPECTED OUTPUTS

DATA AND KNOW-HOW TO IMPLEMENT ELECTRIFICATION ON A RAILWAY LINE DURING THE CONSTRUCTION OF THE RAILWAY

1. LOCOMOTIVES

   - MAINTENANCE TIME, AVAILABILITY
   - MAINTENANCE COSTS (LABOUR AND HARDWARE)
   - ADHESION AND RELATED PERFORMANCE
   - GENERATED AND RADIATED ELECTRO-MAGNETIC INTERFERENCE MEASUREMENTS
   - SPECIAL CREWS AND MAINTENANCE SKILLS REQUIRED
   - ENERGY COSTS

2. POWER DISTRIBUTION - 50 KV 60 Hz

   - HARDWARE COST
   - INSTALLATION COST
   - MAINTENANCE COST

BCR DEMO

EXPECTED OUTPUTS

(CONTINUED)

3. CATENARY

- HARDWARE COST
- INSTALLATION EQUIPMENT AND LABOUR COSTS
- STRUCTURAL INTEGRITY
- CATENARY IMPEDANCE MEASUREMENTS
- OPERATIONAL SAFETY CONSIDERATIONS
- CANADIAN SOURCING
- ESTABLISHMENT OF CANADIAN BASED DESIGN CAPABILITY

4. SIGNALLING - NONE

5. COMMUNICATIONS - NONE

6. GROUNDING

- HARDWARE COST
- INSTALLATION EQUIPMENT AND LABOUR COSTS
- EFFECTIVENESS (INDUCED VOLTAGE MEASUREMENTS)

BCR DEMO

EXPECTED OUTPUTS

(CONTINUED)

7. GROUND RETURN VS RETURN WIRE AND BOOSTER TRANSFORMER
   - HARDWARE COST
   - INSTALLATION COST
   - EFFECTIVENESS FOR MITIGATING INDUCTION INTO OPEN WIRE AND CABLE PARALLEL

8. OVERALL OPERATION CHANGES - NONE

9. SAFETY MEASURES, PERSONNEL AND EQUIPMENT

10. INPUT TO RAILWAY ELECTRIFICATION STANDARDS DOCUMENT

11. PHYSICAL SITE FOR OTHER RAILWAYS TO FURTHER KNOWLEDGE - LIMITED

BRITISH COLUMBIA RAILWAY

August, 1982

TUMBLER RIDGE BRANCH LINE
BACKGROUND INFORMATION

IN GENERAL

- The line will connect Anzac, 77 miles (123 kilometres) north of Prince George, to the townsite of Tumbler Ridge - a distance of 80 miles, or 128 kilometres.

- Currently under construction, the line will be in operation by late 1983.

- The 98-car unit trains bringing the material from the fields will be powered by electricity, making the line the only major electrical train operation in Canada.

- From Prince George, the coal will be transported to Prince Rupert via Canadian National Railway.

- B.C. Railway - a crown corporation operating in a competitive environment - will spend about $450 million on the line.

- Branch line linked to rest of BCR operation by a private microwave communications system and by computer linkups. Precise calculations on amounts of earth excavated are being made with the help of "Earthworks" computer system, set up at the site.

TUNNELS

- Two major tunnels are being built: the nine-kilometre Table, and six-kilometre Wolverine. Two smaller (under a kilometre each) tunnels also will be built.

- Tunnels will be 24 feet, 6 inches high by 18 feet wide. This is somewhat higher than conventional tunnels. The extra height is to accommodate overhead electrical lines and supporting apparati.

BRIDGES

- Eleven bridges (seven of them major bridges) will be built along the line. Several bridges, including a 159-metre prefabricated span at Parsnip River, have already been built. Construction of the bridge employed innovative technology to "launch" the 1,000-tonne structure into place - including a "teeter-totter" balancing system and Teflon pads to reduce friction.

(more)

BRITISH COLUMBIA RAILWAY

ELECTRIFICATION

- Branch line locomotives will be powered by electricity, rather than the more common diesel-powered system, typical to North American railroads. A further innovation will be the use of 50 kilovolt technology. Unlike 25 kv rail technology -- common in Europe and elsewhere -- 50 kv will need only one power substation on the Tumbler Ridge line. Additional substations, necessary with a 25 kv system, would have made the cost of electrification prohibitive.

- Key factors in decision to "go electrical" are: It avoids $15 million in tunnel ventilation costs in the line's two major tunnels; proximity of B.C. Hydro transmission line; provision of federal-provincial energy conservation funding.

- Only two other railroads in the world employ 50 kv technology -- a coal line in Arizona and a mineral railway in South Africa.

HISTORY OF BCR

- The railway -- originally the Pacific Great Eastern -- was incorporated in 1912. Until 1952, the line was limited to a link between Squamish and Quesnel. Since then, however, steady expansion has taken place until now there are over 1,200 miles of main track and 400 miles of branch line between North Vancouver and Fort Nelson.

- In 1972, the company's name was changed to British Columbia Railway. The company employs 2,500 people.

- In the past few years, great changes have taken place in the company. The physical plant -- the railway's ~~roads~~ grade, tracks and bridges -- has been completely rebuilt. In 1976, the railway got its first independent board of directors, assuring total freedom from any interference in its day-to-day operation. In 1979, a major reorganization of management took place and the board of directors appointed a president and chief executive officer (M.C. Norris, who continues to lead the company).

- When shipments on the new line commence, the railway expects to eventually double its current eight-to-nine million tons of freight moved annually to nearly 20 million tons.

-30-

For more information, contact:

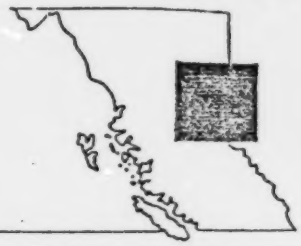
Jerry Collins,
Public Relations Assistant,
B.C. Railway,
681-3131

APPENDIX C

North East Coal Development

P.O. Box 49237
Suite 1764, Bentall IV
1055 Dunsmuir Street, Vancouver, B.C.
V7X 1L3 (604) 668-2326

Hon. Don Phillips, Minister
Ron Basford, Director



FACT SHEET

- largest industrial undertaking in BC's history and the largest mining development in Canada's history

- total in-place capital cost $2.5 billion

- the builders:

  Quintette Coal Limited and Teck Corporation who are constructing two new surface coal mines

  Quintette's mine will be the single largest metallurgical coal mine in Canada, producing at least 6.3 million tonnes of metallurgical and thermal coal annually.

  Teck's mine will produce 1.7 million tonnes of metallurgical coal annually

  BC Rail is upgrading its line and constructing a new 129 km branch line from a midpoint between Prince George and Chetwynd to the new town of Tumbler Ridge. Two tunnels are being constructed - one six kilometres and the other nine kilometres

  BC Hydro is constructing a new 127 km power line from the G.M. Shrum generating station to the mines and Tumbler Ridge

  Ministry of Transportation and Highways is constructing a 92 km two-lane paved highway between Chetwynd and Tumbler Ridge and upgrading the Heritage Highway from Dawson Creek to Tumbler Ridge

  Tumbler Ridge Municipality - developing a new town at Tumbler Ridge for mine employees and their families, merchants, school teachers, doctors and others

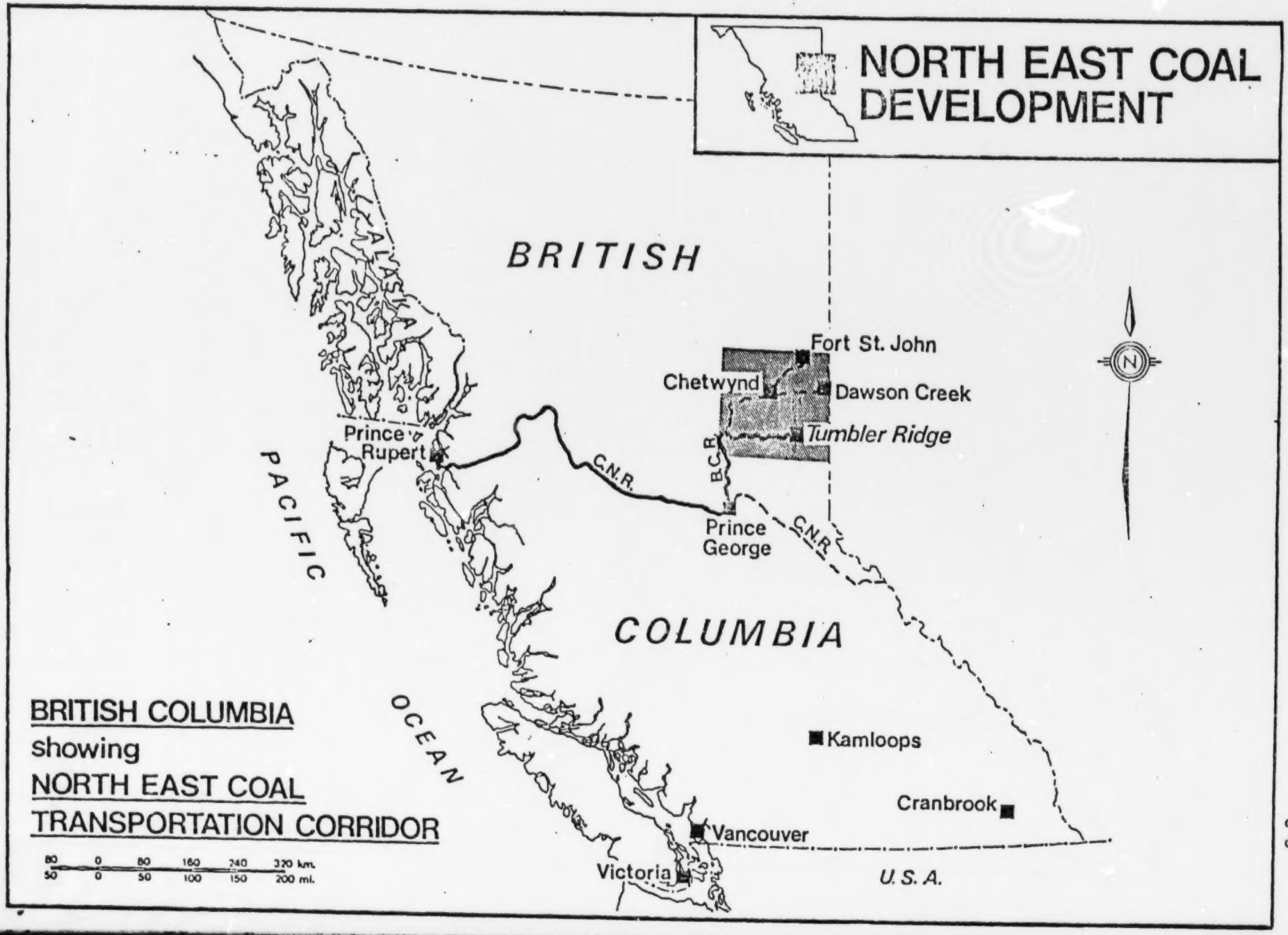
  CN Rail is upgrading its northern line from Prince George to carry unit trains

  National Harbours Board is preparing the coal terminal site on Ridley Island at Prince Rupert, and Ridley Terminals Inc is building new coal handling facilities

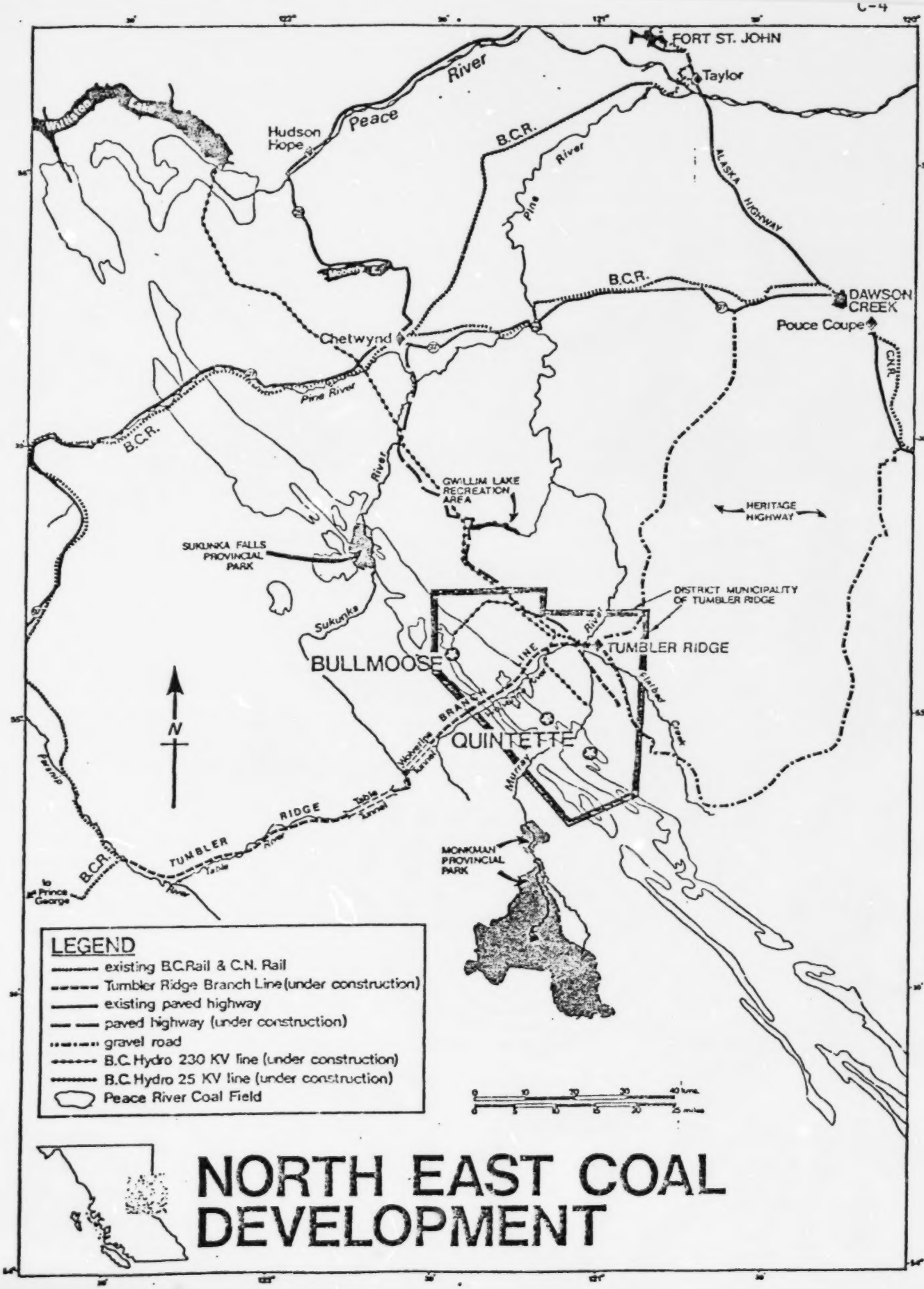
- the mining companies have sales contracts with annual value of $585 million (1980 dollars) nearly double the value of all coal exports from this province in 1980

2.

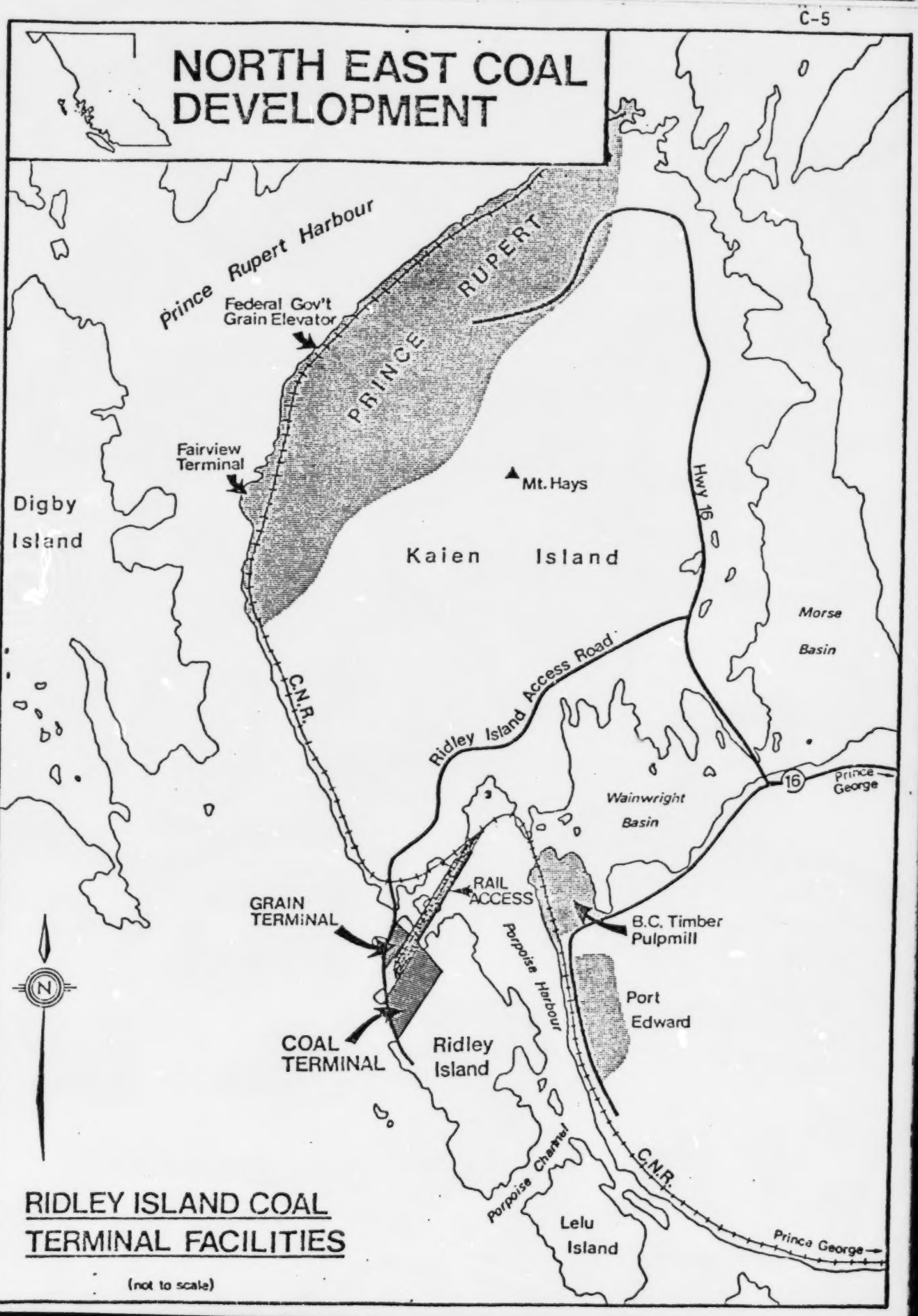
- employment during 1981 totalled 1,000 jobs - three-quarters of those went to northerners, 500 to people in the northeast
- employment in 1982 is expected to top 5,000 jobs - over 10 percent of total construction workforce in BC
- total indirect employment in Canada 46,000 man years
- the mines will provide 2,000 permanent jobs
- 4,600 indirect man years of manpower will be created across Canada flowing out of the employment at the mines
- three new provincial parks have been created



BRITISH COLUMBIA
showing
NORTH EAST COAL
TRANSPORTATION CORRIDOR



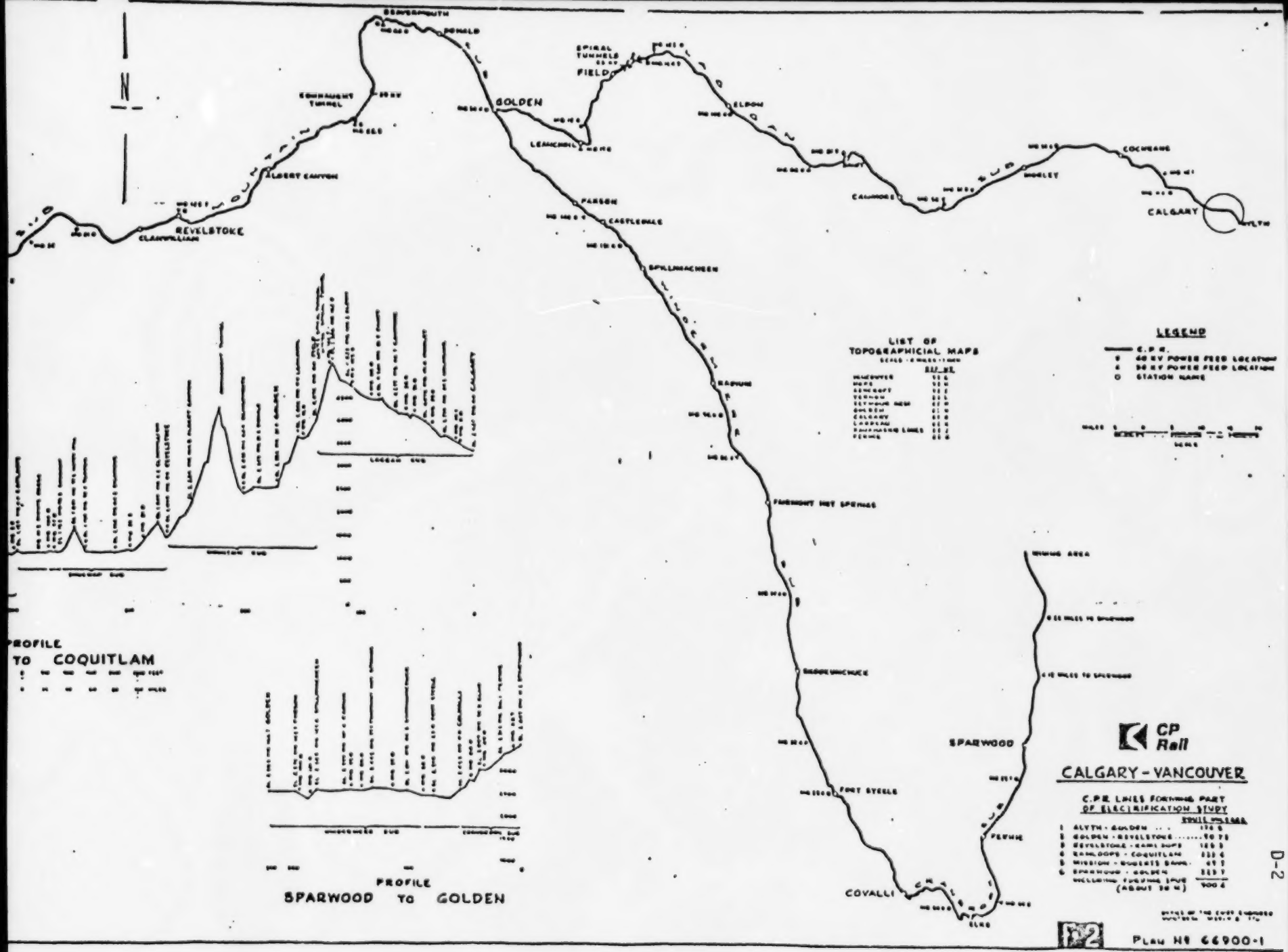
NORTH EAST COAL DEVELOPMENT

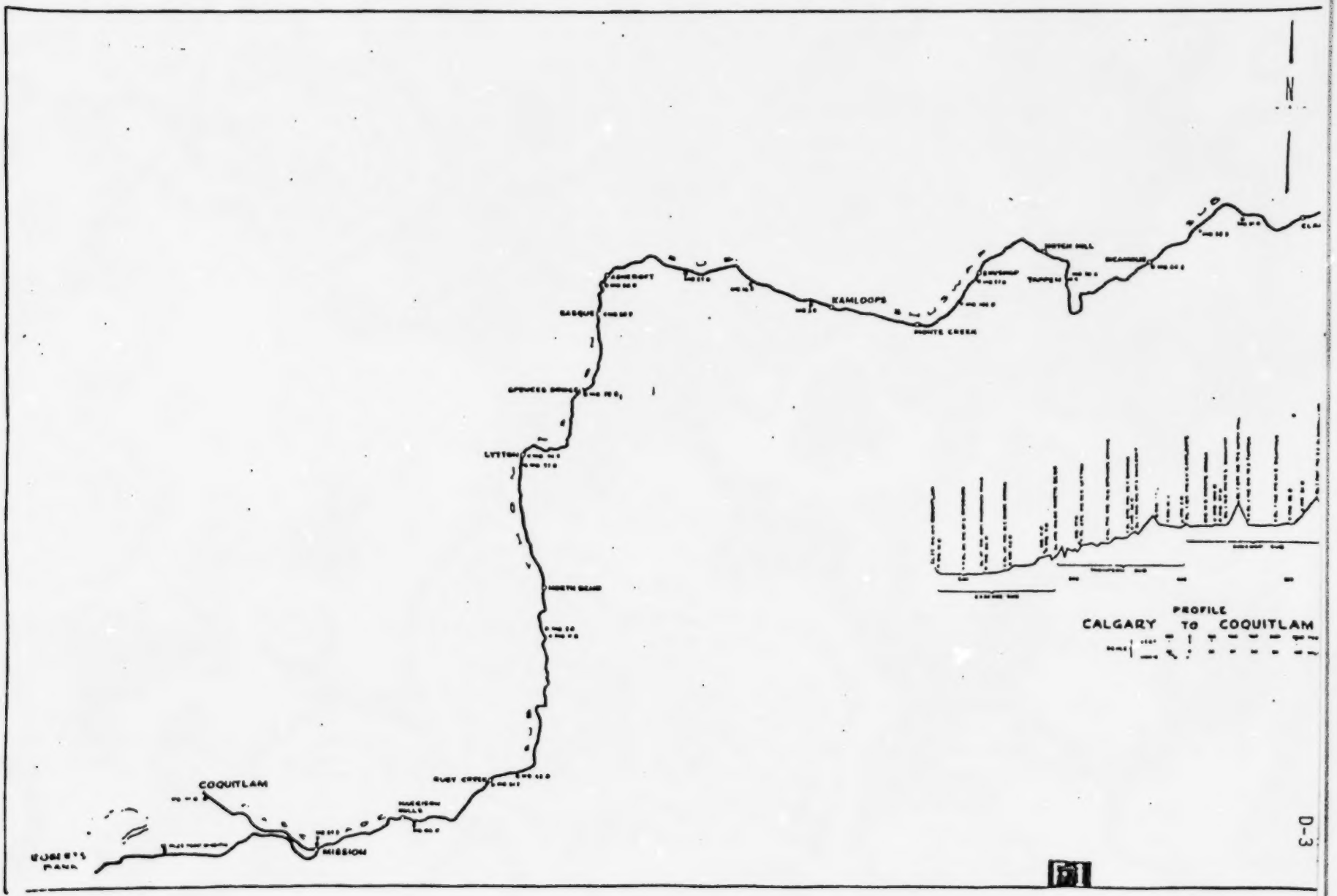

NORTH EAST COAL DEVELOPMENT
Prince Rupert Harbour
Federal Gov't Grain Elevator
PRINCE RUPERT
Fairview Terminal
Digby Island
Mt. Hays
Kaien Island
Hwy 16
Morse Basin
C.N.R.
Ridley Island Access Road
16
Prince George
Wainwright Basin
RAIL ACCESS
GRAIN TERMINAL
B.C. Timber Pulpmill
Porpoise Harbour
Port Edward
COAL TERMINAL
Ridley Island
Porpoise Channel
C.N.R.
Lelu Island
Prince George
N
RIDLEY ISLAND COAL TERMINAL FACILITIES
(not to scale)

SUBSTATION SPACING AND POWER DEMAND

YEAR: 2010 5 minute load for 95% of the time

	50 KV	25 KV	AT 50 KV	AT 25 KV
Calgary-Golden	69 mi.	29 mi.	98 mi.	49 mi.
	40 MVA	20 MVA	60 MVA	40 MVA
32 trains/day				
Headway: 1.5 hours				
49 miles				
(Double Track)				
Golden-Mission	46 mi.	23 mi.	6 mi.	34 mi.
	60 MVA	40 MVA	60 MVA	40 MVA
68 trains/day				
Headway: 0.7 hours				
23 miles	-			
(Double Track)	-			
Mission-Roberts Bank	69 mi.	29 mi.	86 mi.	43 mi.
	40 MVA	20 MVA	60 MVA	40 MVA
36 trains/day				
Headway: 1.33 hours				
43 miles				
(Double Track)				
Mission-Vancouver	69 mi.	29 mi.	98 mi.	49 mi.
	40 MVA	20 MVA	60 MVA	40 MVA
Headway: 1.5 hours				
49 miles				
(Double Track)				


N
REVELSTOKE
GOLDEN
FIELD
CALGARY
LEGEND
LIST OF TOPOGRAPHICAL MAPS
PROFILE
TO COQUITLAM
PROFILE
SPARWOOD TO GOLDEN
CP Rail
CALGARY - VANCOUVER
C.P.R. LINES FORMING PART OF ELECTRIFICATION STUDY
D-2
Plan No 66900-1


N
KAMLOOPS
LYTTON
COQUITLAM
MISSION
PROFILE
CALGARY TO COQUITLAM

ELECTRICAL CONSUMPTION
FIELD-GOLDEN-COQUITLAM AND MISSION-ROBERTS BANK
- 1990 TRAFFIC FORECAST

Subdivision	Proposed Location of 50 KV Substation	Approximate Mile-Board	Average Mw - HR	Max. 15 - Mw	Load Factor	Annual Consumption - KWH ($\times 10^6$)	
Mountain	~~Leanchoil~~ GOLDEN	~~17~~ 35	3.8	20.2	18.7	33.04	
	Beavermouth	62	7.7	22.6	34.1	67.37	
	Glacier	85	17.9	45.4	39.5	156.81	
	Revelstoke	126	9.5	31.8	29.7	82.90	
					Sub-Total		340.12
Shuswap	Malakwa	32	6.8	21.4	31.7	59.77	
	~~Tappen~~ SOLMON ARM	~~69~~ 63	12.7	37.0	34.2	110.94	
	~~Pritchard~~ MONTE CREEK	~~104~~ 111.3	8.1	25.8	31.3	70.63	
					Sub-Total		241.34
Thompson	~~Munro~~ SAVONA	~~172~~ 5.2	9.7	29.1	33.4	85.26	
	Basque	56	8.2	23.3	35.3	71.96	
	Lytton	95	9.5	28.5	33.3	82.89	
					Sub-Total		240.11
Cascade	Spuzzum (East)	11	9.3	27.8	33.6	81.66	
	Ruby Creek	52	8.3	23.1	35.9	72.66	
	Mission	87	4.3	19.5	21.8	37.23	
					Sub-Total		191.55
Spurs	Mission-Coquitlam	24.6 Miles	2.6	14.7	17.5	22.56	
	Mission-Roberts Bank	47.1 Miles	5.9	22.5	26.2	51.53	
					Sub-Total		74.09
					Total Annual Consumption in B.C.		1,087.21

Canadian Pacific
Research Department
Montreal,
October, 1981.

ELECTRICAL CONSUMPTION
FIELD-GOLDEN-COQUITLAM AND MISSION-ROBERTS BANK
- 1990 TRAFFIC FORECAST

Subdivision	Proposed Location of 50 KV Substation	Approximate Mile-Board	Average Mw - HR	Max. 15 - Mw	Load Factor	Annual Consumption - KWH ($\times 10^4$)	
Mountain	~~Leanchoil~~ GOLDEN	~~117~~ 35	3.8	20.2	18.7	33.04	
	Beavermouth	62	7.7	22.6	34.1	67.37	
	Glacier	85	17.9	45.4	39.5	156.81	
	Revelstoke	126	9.5	31.8	29.7	82.90	
					Sub-Total		340.12
Shuswap	Malakwa	32	6.8	21.4	31.7	59.77	
	~~Tappen~~ SALMON ARM	~~69~~ 63	12.7	37.0	34.2	110.94	
	~~Pritchard~~ MONTE CREEK	~~104~~ 111.3	8.1	25.8	31.3	70.63	
					Sub-Total		241.34
Thompson	~~Munro~~ SAVONA	~~117~~ 252	9.7	29.1	33.4	85.26	
	Basque	56	8.2	23.3	35.3	71.96	
	Lytton	95	9.5	28.5	33.3	82.89	
					Sub-Total		240.11
Cascade	Spuzzum (East)	11	9.3	27.8	33.6	81.66	
	Ruby Creek	52	8.3	23.1	35.9	72.66	
	Mission	87	4.3	19.5	21.8	37.23	
					Sub-Total		191.55
Spurs	Mission-Coquitlam	24.6 Miles	2.6	14.7	17.5	22.56	
	Mission-Roberts Bank	47.1 Miles	5.9	22.5	26.2	51.53	
					Sub-Total		74.09
					Total Annual Consumption in B.C.		1,087.21

Canadian Pacific
Research Department
Montreal,
October, 1981.

JRNAL of COMMERCE

, 1979 | Serving Western Construction Since 1911 | 68th Year - No. 102

LRT closer to becoming a maybe

at the GVRD make a decision on the final alignment nd its cost by April, 1980.

The report's recommendations (26 in all) have een referred back to the VRD's transportation committee, which will contact the unicipalities for their comments on the proposed alignents.

An open house has been heduled for January 7, 980, with continued discusn, including a public bate, over February and arch.

After that comes negotiations with the provincial overnment to include LRT in the cost sharing program for B.C. transit. The provincial government would then pay two-thirds and the GVRD one third, of the final cost.

If all goes well, pretender documents could be drawn up by the middle of 1980 and the project could get underway as early as [redacted]. Completion of the first priority line is due [redacted] 1986.

There has been much speculation on the viability of a system which will exclude some lower mainland areas, such as North Vancouver, but planners are determined that LRT is a must, and say some sacrifice from the part is necessary for the good of the whole.

And an additional major criticism, is something the staff committee readily admit themselves — that LRT is "no panacea."

But Fritz Bowers, chairman of the GVRD staff commitee, said LRT is one way of "lessening the worsening" of traffic congestion, estimated to grow an average of 4 to 5 per cent per year, and that in itself, could be crucial to future development.

"The shape of our future development will be partly based on LRT. Without ready mobility, people will build somewhere else rather than make the trip downtown. Having LRT gives the capability to continue to expand in the fashion we've been used to up to now," he said.

And Bowers said that even though the first LRT line would not reach a break-even point until 1995, some of the anticipated $40 million per year mortgage could be offset by savings on the labor end, when one train can do the work of several buses.

Still others feel that the high cost of LRT is only minimal when compared to

(Continued on page 16)

LEGEND
(All Costs Shown In 1979 Dollars)

Full System	
Construction	$349-460 million
Vehicles	$81-98 million
Total	$430-558 million
Downtown-Richmond	
Construction	$89-150 million
Vehicles	$34-43 million
Total	$123-193 million

Downtown-New Westminster (Branches to Surrey & The Lougheed Area — 1st Priority)	
Construction	$222-275 million
Vehicles	$43-51 million
Total	$265-326 million
Third Priority Extension	

THE PROPOSED Light Rapid Transit system for the Greater Vancouver Area. Major criticisms still have to be overcome, but planners are urging quick action to get the project off the ground as soon as possible. Time is of the essense, they say, and though "no panacea" to future traffic congestion, LRT could be a key to future development.

lecom
,w plant

ost of the structure between 35-million to $56-million.

Last month, Northern elecom announced that it ould be undertaking a $5.5-illion expansion to its plant the city's Skyline Industrial Park. Vice also said his most recent announcements, that the company will be building Western Canada's largest rivate laboratory for esearch and development in he Edmonton area.

LBERTA

luor gets Esso's udy Creek job

luor Cannda Ltd. has been warded a $75 million (Canaian) contract by Esso esources Canada Limited. he contract involves moderization and expansion of sso production facilities in he Judy Creek field, norwest of Edmonton. Both nies are based in y.

luor Canada will esign, engineer, procure quipment, and construct acilities to expand inlet eparation capacity, increase as-lift compression, and im-rove instrumentation and

Architect censured for his statements

There is therefore no reservation as to your right to speak out publicly.

"However, Council cannot endorse the manner in which you chose to do so

New Brie

Highway Plan

Alberta Transport to bring portio Highway 16 b Spruce Grove and burn, Alberta up lane, divided stand the end of the 198 building season.

Expansion Studied

Prince George Pul Paper Ltd. (B.C. Intercontinental Company of P.G. a dying a $250 millio that could in upgrading existing facilities and the bi of a new production

Mammoth Pro

Proposals to build $350-million function develop downtown Edm with 120,770m2 of space and 74,320 retail space have made by the city's Five Corp.

Park Announc

Northern Saskatch first industrial park and costing $1.1-m is to be construct Creighton northea Prince Albert in the of 1980.

TIW Additio

TIW Industries Lt Ottawa has formed company, Struthers headquartered in Ca to specialize in oil generators for u primary recovery of crude oil and tar bitumen.

College Get Addition

Pat McGeer, Minis Education, Scienc Technology, has

BRITISH COLUMBIA SUMMARY OF RAIL ELECTRIFICATION

Tracks to be Electrified

Total Track km	First and Second Track - km	Third or More Track - km	Estimated Extra Second Track
3,142	3,627	109	813

Substation Cost Estimate
(Thousands of Dollars)

Material	Direct Labour	Engineering/ Supervision	Other	Total
79,320	19,560	15,480	15,480	129,840

Civil Reconstruction Estimate
(Thousands of Dollars)

Material	Direct Labour	Engineering	Admin	Equipment	Total
21,064	56,169	14,043	14,043	35,106	140,425

Catenary Cost Estimate
(Thousands of Dollars)

Material	Direct Labour	Engineering	Admin	Equipment	Total
268,092	80,217	46,868	80,217	92,223	567,617

Utility Feed Line Requirements

New Line	Upgraded Line	Utility Tie-In
High Voltage (km)	High Voltage (km)	High Voltage
832	652	35

Utility Feed Line Cost Estimate
(Thousands of Dollars)

Material	Direct Labour	Engineering	Admin	Equipment	Total
31,289	27,747	7,695	10,905	11,644	89,280

Communications Cost Estimate Summary
(Thousands of Dollars)

Material	Direct Labour	Engineering	Other	Total
8,203	7,438	2,625	3,609	21,875

APPENDIX G

Inter-office memo ⊕ B.C.Hydro

MEMO TO: M.W. Bodnar 18 March 1983

FROM: G. Ilic

SUBJECT: Rail Electrification of B.C. Portion of the CPR Line, Calgary - Vancouver

---

In response to your memo of 11 March, the latest available figures indicate that some 1,266 GW.h/year of electricity will be consumed by the electric train load on the (possible) electrified Field to Vancouver route in British Columbia.

This represents some 1,445 MW of (average) demand based on 100% load factor, or 290 MW based on 20% load factor.

Engineering estimates by CPR about such loads, map of the route, possible implementation timetable, service assumptions, BCH substations data (load, location) are attached to this memo.

The likelihood of this additional load to BCH's system will depend on a mix of economic and political events as discussed in the BCH Project Report 8216 (Impact of Rail Electrification on B.C. Hydro's Electrical Service Needs 1983-2005).

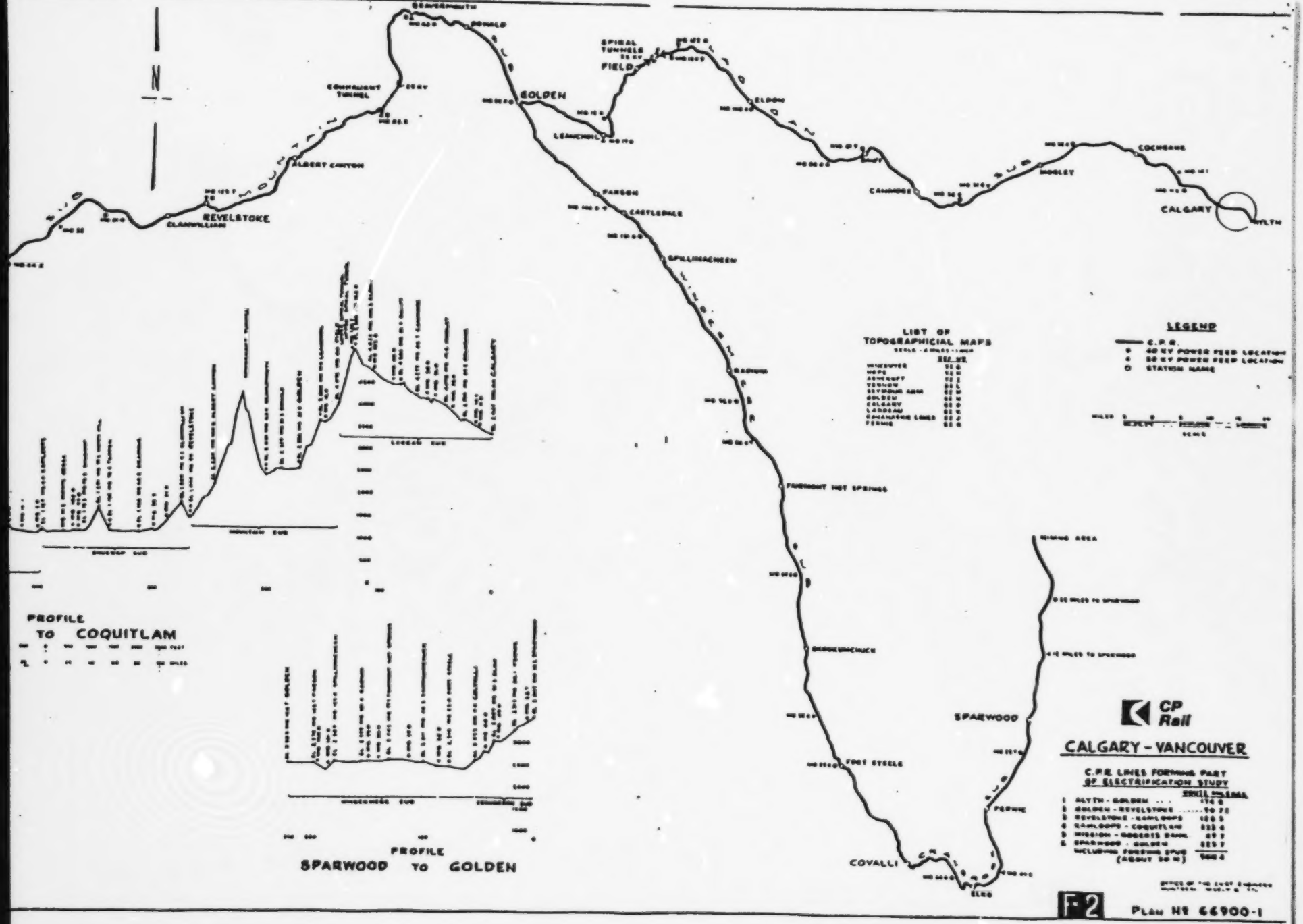
Gad

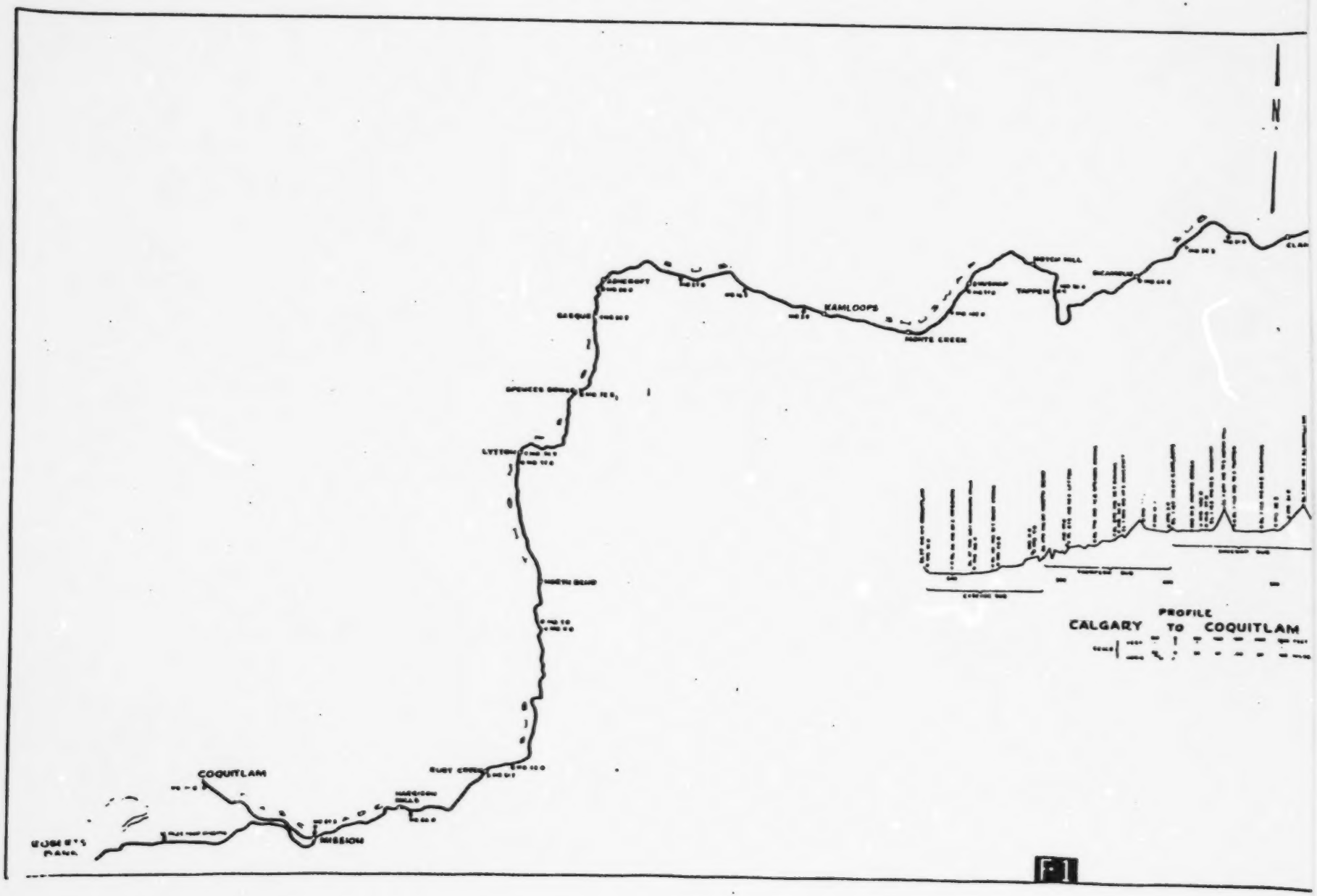
GI/cg

Attach.

cc: R.W. Racine ✓

91908


N
REVELSTOKE
CLANWILLIAM
ALBERT CANYON
GOLDEN
FIELD
LEANCHOIL
PARSON
CASTLEDALE
SPILLIMACHEEN
RADIUM
FARMONT HOT SPRINGS
GOLDSTREAM
FORT STEELE
SPARWOOD
COVALLI
ELKO
ELDON
CANMORE
MORLEY
COCHRANE
CALGARY
LIST OF TOPOGRAPHICIAL MAPS
LEGEND
C.P.R.
STATION NAME
PROFILE TO COQUITLAM
PROFILE SPARWOOD TO GOLDEN
CP Rail
CALGARY - VANCOUVER
C.P.R. LINES FORMING PART OF ELECTRIFICATION STUDY
F2
Plan Nº 66900-1


N
KAMLOOPS
COQUITLAM
MISSION
PROFILE
CALGARY TO COQUITLAM
F-1

ELECTRICAL CONSUMPTION
FIELD-GOLDEN-COQUITLAM AND MISSION-ROBERTS BANK
- 1990 TRAFFIC FORECAST

Subdivision	Proposed Location of 50 KV Substation	Approximate Mile-Board	Average Mw - HR	Max. 15 - Mw	Load Factor	Annual Consumption - KWH (x 10^6)	
Mountain	~~Leanchoil~~ GOLDEN	~~17~~ 35	3.8	20.2	18.7	33.04	
	Beavermouth	62	7.7	22.6	34.1	67.37	
	Glacier	85	17.9	45.4	39.5	156.81	
	Revelstoke	126	9.5	31.8	29.7	82.90	
					Sub-Total		340.12
Shuswap	Malakwa	32	6.8	21.4	31.7	59.77	
	~~Tappen~~ SALMON ARM	~~69~~ 63	12.7	37.0	34.2	110.94	
	~~Pritchard~~ MONTE CREEK	~~104~~ 111.3	8.1	25.8	31.3	70.63	
					Sub-Total		241.34
Thompson	~~Hunro~~ SAVONA	~~1T25.2~~	9.7	29.1	33.4	85.26	
	Basque	56	8.2	23.3	35.3	71.96	
	Lytton	95	9.5	28.5	33.3	82.89	
					Sub-Total		240.11
Cascade	Spuzzum (East)	11	9.3	27.8	33.6	81.66	
	Ruby Creek	52	8.3	23.1	35.9	72.66	
	Mission	87	4.3	19.5	21.8	37.23	
					Sub-Total		191.55
Spurs	Mission-Coquitlam	24.6 Miles	2.6	14.7	17.5	22.56	
	Mission-Roberts Bank	47.1 Miles	5.9	22.5	26.2	51.53	
		912.2			Sub-Total		74.09
					Total Annual Consumption in B.C.		1,087.21

Canadian Pacific
Research Department
Montreal,
October, 1981.

Calgary-Vancouver Electrification

Possible Implementation Time Table

Subdivision		
Cascade North Bend-Coquitlam Mission-Roberts Bank	-	Jan. 1/85-Dec. 31/85 (Power required early in 1986)
Thompson Kamloops-North Bend	-	Jan. 1/86-Dec. 31/86 (Power required early in 1987)
Shuswap Revelstoke-Kamloops	-	July 1/86-July 1/87 (Power required mid 1987)
Mountain Golden-Revelstoke	-	Jan. 1/87-Dec. 31/87 (Power required early in 1988)
Golden-Calgary East of Mountain and Laggan	-	July 1/87-July 1/88 (Power required mid 1988)
Windermere/ Cranbrook/Fording Sparwood-Golden	-	Jan. 1/88-July 1/89 (Power required mid 1989)

ASSUMPTIONS - 2010

Number of tracks	2
Train Headway Distance	49, 23, 43 miles
Trail Load	15 MVA full, 5 MVA empty
Train Power Factor	0.8
Substation Supply Voltage	1.05 p.u.
Minimum Voltage	0.8 p.u.
Utility Fault Level	300 MVA
Transformer reactance	6% on 30 MVA

Calgary-Vancouver
Electrification

Substations for 50 KV - Year 2010

Calgary-Golden

Spacing - Approximately 69 miles
Capacity - 40 MVA

Location	Mileboard (MB)	Subdivision (S/D)
Alyth	0	Calgary Terminals
Canmore	68.7	Laggan
Stephen	122.2	Laggan
Golden	35.0	Mountain

Golden-Mission

Spacing - Approximately 46 miles
Capacity - 60 MVA

Location	Mileboard	Subdivision
Golden	35.0	Mountain
Glacier	85.5	Mountain
Revelstoke	125.7	Mountain
Malakwa	31.9	Shuswap
Salmon Arm	63.2	Shuswap
Montee Creek	111.3	Shuswap
Savona	25.2	Thompson
Basque	55.9	Thompson
Between Lytton and Kanaka	97.0	Thompson

SUBSTATION SPACING AND POWER DEMAND

YEAR: 2010 5 minute load for 95% of the time

	50 KV	25 KV	AT 50 KV	AT 25 KV
Calgary-Golden	69 mi.	29 mi.	98 mi.	49 mi.
	40 MVA	20 MVA	60 MVA	40 MVA
32 trains/day				
Headway: 1.5 hours				
49 miles				
(Double Track)				
Golden-Mission	46 mi.	23 mi.	46 mi.	34 mi.
	60 MVA	40 MVA	60 MVA	40 MVA
68 trains/day				
Headway: 0.7 hours				
23 miles	-			
(Double Track)	-			
Mission-Roberts Bank	69 mi.	29 mi.	86 mi.	43 mi.
	40 MVA	20 MVA	60 MVA	40 MVA
36 trains/day				
Headway: 1.33 hours				
43 miles				
(Double Track)				
Mission-Vancouver	69 mi.	29 mi.	98 mi.	49 mi.
	40 MVA	20 MVA	60 MVA	40 MVA
Headway: 1.5 hours				
49 miles				
(Double Track)				